Zachary M. Subin, Ph.D.

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC.   San Francisco, CA
Senior Consultant

Dr. Subin's work focuses on modeling the economic feasibility of alternative strategies for climate mitigation across all sectors of the economy and the policy implications of large-scale change in the energy system. He joined E3 in 2016, bringing with him more than eight years of combined research experience in the areas of climate science and climate policy. His doctoral and postdoctoral research focused on ecosystem modeling in the context of global climate models used to assess century-scale climate change. His education included training in physics, policy analysis and economics, energy and environmental engineering, and climate science. His skills feature extensive work building computational models and communicating technical information to diverse audiences.

Dr. Subin brings scientific rigor to the analysis of energy systems and their environmental impacts. He believes that thoughtful policy can transform the energy system in a way that minimizes climate impacts while addressing priorities around cost, reliability, and equity. He is especially interested in trade-offs among low-carbon technologies such as electric vehicles and biofuels. Select E3 projects include:

o **California Energy Commission "Future of Natural Gas," 2017-present:** Developing scenarios investigating the feasibility of decarbonizing building heating, including development of an optimal biofuels portfolio model in Python. The project compares decarbonization strategies focused on building electrification and ones focused on renewable natural gas, including the potential for disparate impacts on disadvantaged communities.

o **New York State Energy Research and Development Authority, 2017-present:** Conducting a literature review and supporting modeling to assess the viability of 100% renewable energy for New York State.

o **California Energy Commission "Long Term Energy Scenarios," 2016-2017:** Used E3's PATHWAYS model to develop scenarios investigating alternative pathways to reaching the state's ambitious 2050 greenhouse gas reduction goals, addressing questions such as how deep an electricity-focused decarbonization strategy can go if limited biofuels are available.

o **California Air Resources Board "Scoping Plan Update," 2016-2017:** Supported development of E3's PATHWAYS energy and economic system model to create scenarios for meeting the state's 2030 climate goals.

o **Oregon Department of Environmental Quality, 2016-2017:** Reviewed the environmental economics and policy literature to provide context for a market-based greenhouse gas emissions reduction policy in Oregon, to provide guidance on cap-and-trade design and related questions.

Research Experience

LAWRENCE BERKELEY NATIONAL LABORATORY, EARTH SCIENCE DIVISION   Berkeley, CA
Postdoctoral Fellow   2014-2016

- o Worked with George Pau and William Riley developing Machine-Learning/Reduced-Order Modeling techniques for terrestrial climate model applications.

PRINCETON UNIVERSITY, ENVIRONMENTAL INSTITUTE   Princeton, NJ
Postdoctoral Fellow   2012-2014

- o Worked with Stephen Pacala, Elena Shevliakova, Chris Milly, and Steve Frolking in the Princeton Environmental Institute and Geophysical Fluid Dynamics Laboratory modeling hillslope hydrology in a global climate model.

LAWRENCE BERKELEY NATIONAL LABORATORY   Berkeley, CA
Graduate Research Assistant   2008-2012

- o Advised by William Riley, Margaret Torn and William Collins for Ph.D. dissertation research. Modeled land cover change, lake and permafrost temperatures and surface fluxes, and wetland and methane biogeochemistry in regional and global climate models.

Education

University of California, Berkeley   Berkeley, CA
Ph.D., Energy and Resources   June 2012

University of California, Berkeley   Berkeley, CA
M.S., Energy and Resources   June 2008

University of California, Berkeley   Berkeley, CA
M.P.P., Goldman School of Public Policy   June 2007

Harvard University   Cambridge, MA
A.B., Physics and Math   May 2003

Citizenship

United States

Selected Peer-Reviewed Publications

1. *Frolking, S., J. Talbot, and Z. M. Subin, 2014. Exploring the relationship between peatland net carbon balance and apparent carbon accumulation rate at century to millennial time scales. The Holocene, 4: 1167-1173.*

2. Koven, C. D., W. J. Riley, Z. M. Subin, J. Y. Tang, M. S. Torn, W. D. Collins, G. B. Bonan, D. M. Lawrence, and S. C. Swenson, 2013. The effect of vertically-resolved soil biogeochemistry and alternate soil C and N models on C dynamics of CLM4. Biogeosciences 10, 7109-7131.

3. Z. M. Subin, C. D. Koven, W. J. Riley, M. S. Torn, D. M. Lawrence, and S. C. Swenson, 2013. Effects of Soil Moisture on the Responses of Soil Temperatures to Climate Change in Cold Regions. Journal of Climate 26, 3139-3158.

4. Melton, J. R., R. Wania, E. L. Hodson, B. Poulter, B. Ringeval, R. Spahni, T. Bohn, C. A. Avis, D. J. Beerling, G. Chen, A. V. Eliseev, S. N. Denisov, P. O. Hopcroft, D. P. Lettenmaier, W. J. Riley, J. S. Singarayer, Z. M. Subin, H. Tian, S. Zürcher, V. Brovkin, P. M. van Bodegom, T. Kleinen, Z. C. Yu, and J. O. Kaplan, 2013. Present state of global wetland extent and wetland methane modelling: conclusions from a model intercomparison project (WETCHIMP). Biogeosciences 10, 753-788.

5. Z. M. Subin, W. J. Riley, and D. Mironov, 2012. An Improved Lake Model for Climate Simulations: Model Structure, Evaluation, and Sensitivity Analyses in CESM1. J. Adv. Mod. Earth Sys. 4, M02001.

6. C. Bonfils, T. J. Phillips, D. M. Lawrence, P. Cameron-Smith, W. J. Riley, Z. M. Subin, 2012. On the influence of shrub height and expansion on boreal climate. Environmental Research Letters 7, 015503.

7. Z. M. Subin, L. N. Murphy, F. Li, C. Bonfils, and W. J. Riley, 2012. Boreal Lakes Moderate Seasonal and Diurnal Temperature Variation and Perturb Atmospheric Circulation: Analyses in the Community Earth System Model 1 (CESM1). Tellus A **64**, 15639.

8. W. J. Riley, Z. M. Subin, D. M. Lawrence, S. C. Swenson, M. S. Torn, L. Meng, N. Mahowald, and P. Hess, 2011. Barriers to predicting changes in global terrestrial methane fluxes: analyses using CLM4Me, a methane biogeochemistry model integrated in CESM. Biogeosciences 8, 1925-1953.

9. Z. M. Subin, W. J. Riley, J. Jin, D. S. Christianson, M. S. Torn, and L. M. Kueppers, 2011. Ecosystem Feedbacks to Climate Change in California: Development, Testing, and Analysis Using a Coupled Regional Atmosphere and Land-Surface Model (WRF3-CLM3.5). Earth Interactions, 15, 1–38.